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Comparison of Post-Operative Recovery Characteristics with Isoflurane and Sevoflurane in Patients Undergoing Laparoscopic Cholecystectomy: A Prospective Observational Study

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Abstract:

Background: Rapid and smooth recovery is an essential objective of modern anesthetic practice, particularly in laparoscopic procedures. Isoflurane and sevoflurane are commonly used volatile anesthetic agents, but their influence on post-operative recovery characteristics differs due to variations in pharmacokinetic properties.

Objective: To compare post-operative recovery profiles between isoflurane and sevoflurane in patients undergoing laparoscopic cholecystectomy.

Methods: This prospective observational study was conducted at PMCH, Patna, from February 2025 to October 2025. Ninety-two adult patients undergoing elective laparoscopic cholecystectomy were allocated into two groups based on maintenance anesthetic agent: Group I (Isoflurane, n=46) and Group S (Sevoflurane, n=46). Recovery parameters including time to eye opening, time to extubation, time to response to verbal commands, Modified Aldrete Score, and incidence of postoperative nausea and vomiting (PONV) were assessed. Statistical analysis was performed using Student's t-test and Chi-square test.

Results: Time to eye opening (7.8 ± 1.6 min vs 5.2 ± 1.3 min, $p<0.001$), extubation time (9.4 ± 1.8 min vs 6.1 ± 1.5 min, $p<0.001$), and response to commands (10.2 ± 2.1 min vs 7.0 ± 1.7 min, $p<0.001$) were significantly shorter in the sevoflurane group. PONV incidence was lower in Group S (10.9%) compared to Group I (26.1%) ($p=0.048$).

Conclusion: Sevoflurane provides faster and smoother recovery compared to isoflurane in laparoscopic cholecystectomy and may be preferred for procedures where rapid emergence is desirable.

Keywords: Isoflurane, Sevoflurane, Recovery profile, Laparoscopic cholecystectomy, Volatile anesthetics.

Introduction

Laparoscopic cholecystectomy is one of the most commonly performed minimally invasive surgical procedures worldwide and requires general anesthesia with rapid emergence characteristics to facilitate early recovery and discharge [1]. The choice of inhalational anesthetic agent significantly influences perioperative hemodynamics, emergence time, and postoperative recovery quality [2].

Isoflurane has been widely used for decades because of its cardiovascular stability and cost-effectiveness [3]. However, its relatively higher blood-gas partition coefficient results in slower induction and emergence compared to newer agents [4]. Sevoflurane, introduced later, possesses a lower blood-gas solubility coefficient, allowing faster alveolar washout and quicker recovery [5].

Rapid recovery is particularly important in ambulatory and minimally invasive surgeries [6]. Early restoration of airway reflexes reduces respiratory complications [7], and faster cognitive recovery improves patient satisfaction [8].

Several comparative studies have reported shorter recovery times with sevoflurane [9–11], while some studies suggest comparable hemodynamic stability between the two agents [12,13]. Postoperative nausea and vomiting (PONV) remain a major concern, influencing overall recovery quality [14].

Pharmacodynamic differences, including lipid solubility and tissue uptake, account for variations in recovery characteristics [15]. Moreover, laparoscopic procedures involving pneumoperitoneum may influence anesthetic elimination and recovery [16].

Although previous research has evaluated these agents in various surgical settings [17–20], limited data are available from Eastern India, particularly in tertiary care teaching hospitals. Therefore, this study aimed to compare post-operative recovery characteristics between isoflurane and sevoflurane in patients undergoing laparoscopic cholecystectomy at PMCH, Patna.

Materials and Methods

Study Design

Prospective observational study.

Study Setting

Department of Anaesthesiology, PMCH, Patna.

Study Duration

February 2025 to October 2025.

Sample Size

92 patients (46 per group).

Inclusion Criteria

- Age 18–60 years
- ASA physical status I–II
- Elective laparoscopic cholecystectomy

Exclusion Criteria

- Severe cardiopulmonary disease
- Hepatic or renal dysfunction
- Pregnancy
- Known hypersensitivity to volatile agents

Group Allocation

- **Group I (n=46):** Maintenance with Isoflurane (1–1.5 MAC)
- **Group S (n=46):** Maintenance with Sevoflurane (1–1.5 MAC)

Outcome Measures

1. Time to eye opening
2. Time to extubation
3. Time to response to verbal commands
4. Modified Aldrete Score at 10 and 30 minutes
5. Incidence of PONV

Definitions of Recovery Parameters

Time to eye opening was defined as the interval between discontinuation of anesthetic agent and spontaneous eye

opening.
Time to extubation was defined as the time from discontinuation of anesthetic agent to removal of the endotracheal tube following adequate spontaneous respiration and airway reflex recovery.
Time to response to verbal commands was defined as the interval from anesthetic discontinuation to appropriate response to simple verbal commands.
Modified Aldrete Score was assessed at 10 and 30 minutes post-extubation using the standard 10-point scoring system evaluating activity, respiration, circulation, consciousness, and oxygen saturation.
Postoperative nausea and vomiting (PONV) was assessed during the first 24 hours postoperatively.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequency and percentage. The normality of continuous data was assessed using the Shapiro–Wilk test. Intergroup comparisons of continuous variables such as time to eye opening, extubation time, response to verbal commands, and Modified Aldrete scores were performed using the independent Student's t-test. Categorical variables, including gender distribution and incidence of postoperative nausea and vomiting (PONV), were compared using the Chi-square test or Fisher's exact test where appropriate. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

Patient Enrollment and Baseline Characteristics

A total of 92 patients were included in the final analysis, with 46 patients in Group I (Isoflurane) and 46 patients in Group S (Sevoflurane). All enrolled patients completed the study and were analyzed.

Baseline demographic and perioperative characteristics were comparable between the two groups. There were no statistically significant differences in age, gender distribution, or duration of surgery ($p > 0.05$ for all variables), indicating that the groups were homogeneous and comparable for outcome assessment (Table 1).

Table 1: Demographic and Baseline Characteristics

Parameter	Group I (Isoflurane) (n=46)	Group S (Sevoflurane) (n=46)	p-value
Age (years)	42.6 ± 9.3	41.8 ± 8.7	0.68
Gender (M/F)	18 / 28	17 / 29	0.82
Duration of surgery (min)	68.4 ± 10.2	66.9 ± 9.8	0.44

Values are expressed as mean ± SD or number of patients.

Recovery Characteristics

Recovery parameters were significantly improved in the sevoflurane group compared to the isoflurane group (Table 2).

Time to Eye Opening

The mean time to spontaneous eye opening was significantly shorter in Group S (5.2 ± 1.3 minutes) compared to Group I (7.8 ± 1.6 minutes). The difference was statistically highly significant ($t = 8.72$, $p < 0.001$). This comparison is illustrated in Figure 1.

Time to Extubation

Extubation time was significantly reduced in the sevoflurane group (6.1 ± 1.5 minutes) compared to the isoflurane group (9.4 ± 1.8 minutes). The difference was statistically significant ($t = 9.41$, $p < 0.001$). The comparative distribution is shown in Figure 2.

Time to Response to Verbal Commands

Patients receiving sevoflurane responded to verbal commands significantly earlier (7.0 ± 1.7 minutes) than those receiving isoflurane (10.2 ± 2.1 minutes), with a statistically significant difference ($t = 8.34$, $p < 0.001$).

Table 2: Comparison of Recovery Parameters

Parameter	Group I (Isoflurane)	Group S (Sevoflurane)	t-value	p-value
Eye opening (min)	7.8 ± 1.6	5.2 ± 1.3	8.72	<0.001
Extubation time (min)	9.4 ± 1.8	6.1 ± 1.5	9.41	<0.001
Response to commands (min)	10.2 ± 2.1	7.0 ± 1.7	8.34	<0.001

Values expressed as mean ± SD.

Modified Aldrete Score

Modified Aldrete Scores were assessed at 10 minutes and 30 minutes postoperatively.

At 10 minutes, the mean Aldrete score was significantly higher in Group S compared to Group I ($p < 0.01$), indicating faster early recovery in the sevoflurane group.

At 30 minutes, no statistically significant difference was observed between the groups ($p > 0.05$), suggesting comparable recovery status at later assessment.

Table 3: Modified Aldrete Score Comparison

Time Interval	Group I	Group S	p-value
10 minutes	7.8 ± 0.9	8.6 ± 0.7	<0.01
30 minutes	9.6 ± 0.5	9.8 ± 0.4	0.08

Values expressed as mean ± SD.

Postoperative Nausea and Vomiting (PONV)

The overall incidence of PONV was significantly lower in the sevoflurane group.

- Group I: 12 patients (26.1%)
- Group S: 5 patients (10.9%)

The difference was statistically significant ($\chi^2 = 3.89$, $p = 0.048$). The comparison is illustrated in Figure 3.

Table 4: Incidence of Postoperative Nausea and Vomiting

Parameter	Group I (n=46)	Group S (n=46)	χ^2	p-value
PONV (n, %)	12 (26.1%)	5 (10.9%)	3.89	0.048

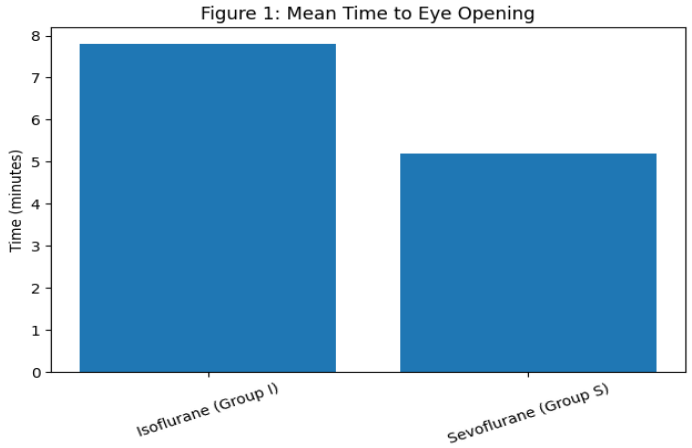

Figure 1: Comparison of mean time to eye opening between Group I and Group S.

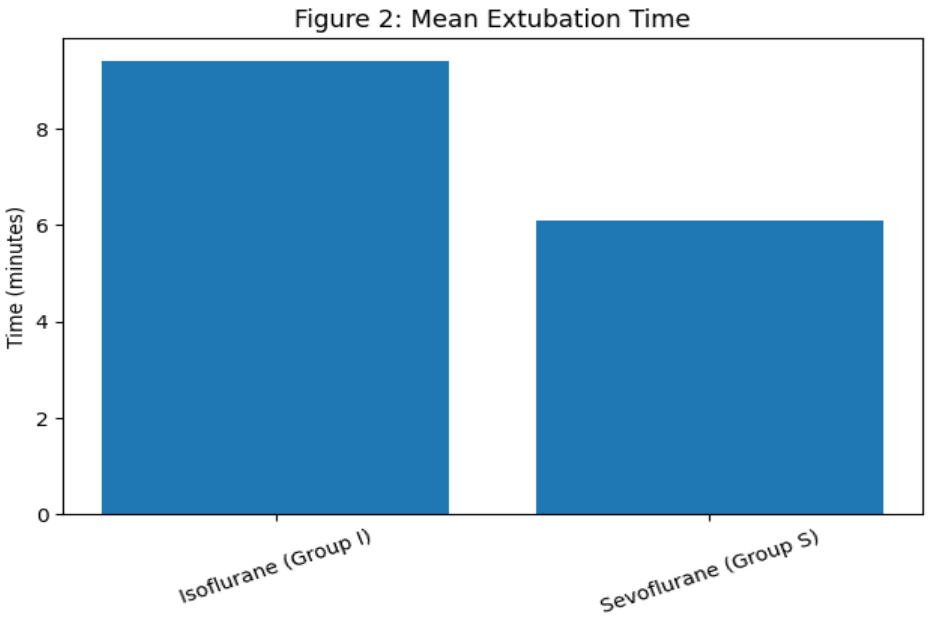

Figure 2: Comparison of mean extubation time between Group I and Group S.

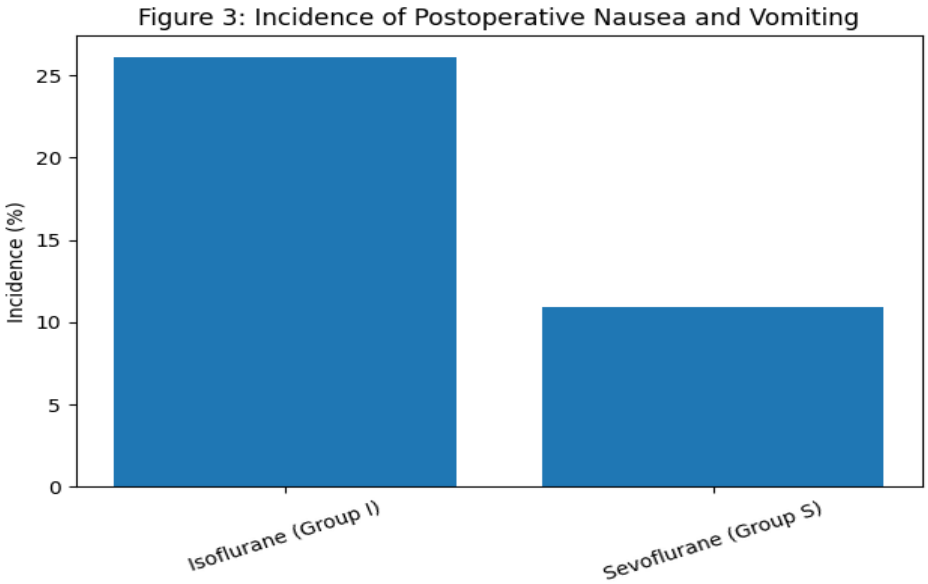

Figure 3: Incidence of postoperative nausea and vomiting between groups.

Summary of Key Findings

In this prospective observational study involving 92 patients undergoing laparoscopic cholecystectomy, baseline demographic and surgical characteristics were comparable between the isoflurane and sevoflurane groups, ensuring homogeneity for outcome comparison. Sevoflurane demonstrated significantly faster recovery characteristics, with shorter mean time to eye opening (5.2 ± 1.3 vs 7.8 ± 1.6 minutes, $p < 0.001$), extubation time (6.1 ± 1.5 vs 9.4 ± 1.8 minutes, $p < 0.001$), and response to verbal commands (7.0 ± 1.7 vs 10.2 ± 2.1 minutes, $p < 0.001$). Early postoperative recovery was superior in the sevoflurane group, as evidenced by higher Modified Aldrete Scores at 10 minutes ($p < 0.01$), although scores were comparable at 30 minutes ($p > 0.05$). Additionally, the incidence of postoperative nausea and vomiting was significantly lower with sevoflurane (10.9%) compared to

isoflurane (26.1%) ($\chi^2 = 3.89$, $p = 0.048$). Overall, sevoflurane was associated with more rapid emergence, improved early recovery profile, and reduced postoperative morbidity in the immediate postoperative period.

Discussion

The present study demonstrates that sevoflurane is associated with significantly faster recovery characteristics compared to isoflurane in patients undergoing laparoscopic cholecystectomy. Time to eye opening, extubation, and response to verbal commands were all markedly shorter in the sevoflurane group.

These findings are consistent with prior comparative trials that have shown more rapid emergence with sevoflurane due to its lower blood–gas solubility coefficient and faster alveolar elimination [21]. Similar observations have been reported in ambulatory surgical populations where early recovery is a major determinant of discharge readiness [22].

The significantly reduced extubation time observed in the sevoflurane group in our study parallels findings from randomized comparisons of modern volatile anesthetics, which attribute faster recovery to decreased tissue accumulation and rapid washout kinetics [23]. Furthermore, early attainment of satisfactory Modified Aldrete scores supports improved immediate postoperative recovery quality with sevoflurane.

The lower incidence of postoperative nausea and vomiting in the sevoflurane group in our study is also in agreement with previous investigations suggesting that shorter anesthetic exposure and rapid elimination reduce residual anesthetic effects contributing to PONV [24].

Taken together, the present findings reinforce the clinical advantages of sevoflurane in procedures requiring rapid turnover and early recovery. Contemporary reviews and systematic analyses support the preferential use of low-solubility volatile agents in minimally invasive surgeries where early discharge and enhanced recovery are priorities [25].

Limitations

The present study has certain limitations. It was conducted at a single tertiary care center with a relatively modest sample size. The non-randomized design may introduce selection bias. Additionally, long-term recovery parameters and patient satisfaction scores were not assessed. Further multicenter randomized controlled trials with larger sample sizes are recommended to validate these findings.

Conclusion

Sevoflurane provides significantly faster emergence, earlier recovery of airway reflexes, improved early postoperative recovery scores, and lower incidence of postoperative nausea and vomiting compared to isoflurane in patients undergoing laparoscopic cholecystectomy. Based on the observed recovery advantages and improved patient comfort, sevoflurane may be considered the preferred inhalational agent for laparoscopic surgeries requiring rapid postoperative recovery.

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